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Biology and rate of food consumption of banana skipper *Erionota torus* Evans (Hesperiidae: Lepidoptera)

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ABSTRACT: Studies on life history of banana skipper, *Erionota torus* indicated female laid eggs in clusters on the under surface of the leaves of the banana plant. Incubation, total larval and pupal period ranged from 7 - 9 days, 26 - 33 days and 10 - 12 days, respectively. Fecundity of the female ranged from 18 -29 eggs. The amount of food consumed increased from II to V instars (10.28, 23.13, 25.01 and 41.56 % respectively). The weight gain in third instar was 33.51% of total larval weight. The values of growth rate (GR) decreased from II to V instar, the values varied between 0.03 and 0.16 g/day/g. Consumption index ranged between 0.64 and 2.15 g/day/g. The indices of food utilization efficiencies namely; AD values ranged from 80.89 to 97.86%, ECI 6.86 to 13.00 % and ECD 7.90 to 15.90 %.

KEY WORDS: Banana, *Erionota torus,* life history and food consumption rate

INTRODUCTION

The banana skipper or banana leaf-roller or red eye skipper, *Erionota torus* Evans, is a common banana pest in continental Southeast Asia, ranging from Sikkim to south China, Burma, Malaya and Vietnam (Corbet and Pendlebury, 1978; Inoue and Kawazoe, 1970: Okolle *et al*., 2006). In India, it appears that *Erionota torus* is the correct identity of the banana skipper which was earlier reported as *Erionota thrax*. It has been reported from Calcutta and Assam (Wynter Blyth, 1957); from Andaman and Nicobar Islands (Veenakumari and Mohanraj, 1991), Manipur (Prasad and Singh, 1987; Singh, 1997), Palani Hills (Ghorpade and Kunte, 2010), Chattisgarh and Madhya Pradesh (Tipple and Ghorpade, 2012), north districts of Kerala (Sivakumar *et al*., 2014), Coimbatore and Erode Districts of Tamil Nadu and Chamrajnagar District (Padmanaban, 2014), Bangalore (Kamala jayanthi *et al*., 2015) of Karnataka. The current outbreaks in South India (Karnataka, Kerala, Tamilnadu, Maharashtra, Andhra Pradesh) may be due to the absence of insecticidal applications coupled with low prevalence of natural enemies and possible climate shifts that would have helped the banana skipper populations to reach damaging thresholds (Raju *et al.,* 2015). The larva causes considerable damage to banana foliage by rolling the leaf while feeding on it (Chiang and Hwang, 1991). The larvae of these butterflies can cause mean defoliation of about 60 per cent, leading to yield loss of about 20 per cent (Okolle *et al*., 2010). During September 2014, there was an out break of *Erionota torus* in Coastal belts of Karnataka (Dakshina Kannada, Udupi and Uttar Kannada) and then spread to Malnad districts of Karnataka. This pest was so far not reported from this region either as a major

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or as a minor pest on banana in costal belt of Karnataka. Review of literature revealed scanty information on biology of *E. torus* on banana. Hence this study was undertaken.

MATERIALS AND METHODS

The study was conducted during July – October 2015 under laboratory conditions at Department of Agricultural Entomology, College of Agriculture, UAHS, Shivamogga (13° 58' N ; and 74° 84'E ; 613 MSL). During the study period, average temperature and relative humidity ranged from 24.8 to 27.3°C and 65 to 81 per cent, respectively.

Sufficient number of larvae and pupae was collected from unprotected banana field and brought to the laboratory. The larvae and pupae were kept in an insect rearing cage of size (30 X 30 X 45 cm) till adult emergence which served as a source of initiating the pure culture under laboratory condition. Ten pairs of newly emerged male and female adults were released in a green house condition (20 ft length X 25 feet width X 20 ft height) and inside that five banana plants (six months old, local banana variety - Ney Pooven (AB group)) were kept for egg laying. Banana inflorescence was kept nearer to banana plant which helped in getting nector for the adult male and female butterflies. Pure culture was started with eggs of the female on banana leaves collected from green house. The collected eggs were kept in a petriplate of having size of 5 cm diameter. The eggs were then examined at an interval of 6 hours for recording time to eclosion. After hatching, the first and second instar larvae were reared individually on fresh banana leaf which served as food and food was changed daily. The larvae were subsequently reared on a weighed quantity of fresh banana leaves supplied daily. Third, fourth and fifth instar larvae were reared in a plastic tub having size of 16 cm bottom diameter X 18.5 cm, top diameter X 22 cm height on rolled fresh banana leaf which served as food and changed daily. The larvae were examined daily for ecdysis. Head cap-sules were collected and kept in 70% ethanol. The length and width of the head capsules of different instars were measured using an ocular micrometer. Adult male and female longevity was recorded by releasing in a rearing cage (30 cm X 30 cm X 45 cm) and 10 per cent honey was provided and was replenished daily.

The morphological characters, body measurements, body weight of each instar and the faeces egested were taken daily. The prepupal period, pupal period, sexing of male and female and the time of adult emergence were also recorded. Daily observations were recorded on initial weight of the leaf, final weight of leaf, larval faeces, and larval weight. Regarding pre-oviposition, oviposition, post-oviposition periods and fecundity for females and adult male and female longevity were also recorded. Observations were made on the morphometry of all the stages *viz.,* egg, grub, pupa and adult by using occular micrometer. Larval performance in terms of food utilization indices were calculated as described by Waldbauer (1968) as:

$$\text{Food consumption index (C.I.)} = \frac{\text{Wt. of food consumed}}{\text{Wt. of instar x No. of feeding days}}$$

$$\text{Relative growth rate (G. R.)} = \frac{\text{Wt. gained by the instar}}{\text{Mean wt. of instar x No. of feeding days}}$$

$$\text{Approximate digestibility (A. D.)} = \frac{\text{Wt. of food ingested - Wt. of faeces}}{\text{Wt. of food ingested}} \times 100$$

$$\text{Efficiency of conversion of digested food (E. C. D.)} = \frac{\text{Wt. gained by the instar}}{\text{Wt. of food consumed - Wt. of faeces}} \times 100$$

$$\text{Efficiency of conversion of ingested food (E. C. I.)} = \frac{\text{Wt. gained by the instar}}{\text{Wt. of food ingested}} \times 100$$

RESULTS AND DISCUSSION

Egg: Gravid female laid eggs in clusters (n = 75) on the under surface of the leaves of the banana plant mostly nearer to the edge of the leaf (Fig. 1-3). Majority of females laid eggs in groups ranged from 11 to 30 (n = 50) but rarely eggs were found singly on upper surface of the leaf (1 to 2 per cent), midrib and sometimes when the infestation was high, adults also found to lay eggs on dried leaf also. Female preferred to lay eggs on top 4th to 6th leaves from

Fig 1. Freshly laid eggs

Fig 2. Eggs turned to pink colour

Fig 3. Eggs laid on midrip one day before hatching

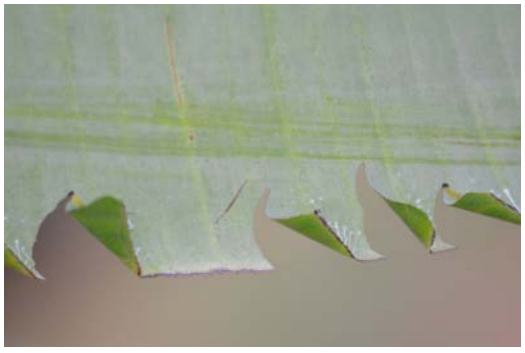

Fig 4. I Instar

Fig 5. III Instar

Fig 6. V Instar

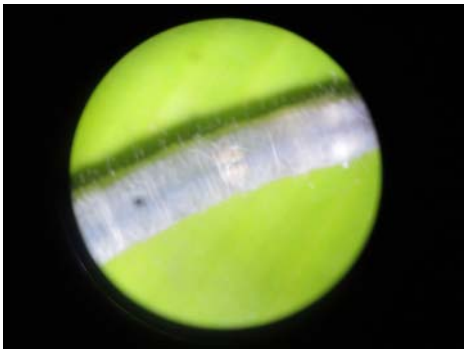

Fig 7. Gonads on VI abdominal segment

Fig 8. Pupa

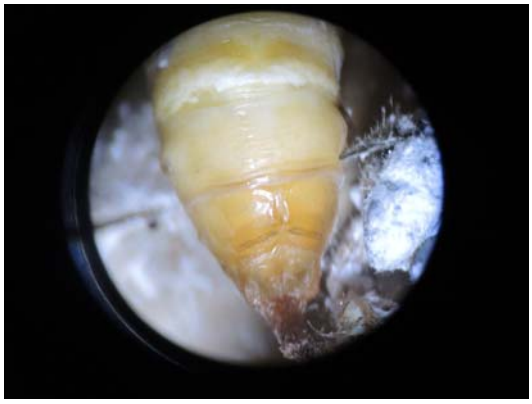

Fig 9. Female Pupa

Fig 10. Male Pupa

Fig 11. Male

Fig 12. Female

Fig 13. Adult feeding on inflorescence

top. The eggs were dorsoventrally flattened, initially they were yellow in colour (Fig. 1) for one or two days turned to bright pinkish in colour (Fig. 2). Two days before hatching, the eggs turned to white with black head capsule of the developing larva become visible through the chorion (Fig. 3). Incubation period ranged from 7 - 9 days with a mean of 7.99 days (Table 1). There were 26-29 clearly expressed longitudinal ridges on chorion with a mean of 28.1 ridges. These measurements compare favorably with those of Hoffmann (1935), Waterhouse and Norris (1989) and Bascombe *et al*. (1999), Gunawardana *et al*. (2015) who studied the biology of *E. torus*. However, these results are in contrast with Igarashi and Fakuda (1997) who stated that normally eggs are singly laid on upper surface of the leaf. The average number of longitudinal ridges on chorion with a mean of 28.1 ridges on *E. torus.* However, there is no much variation with the diameter of the egg with respect to *E. torus* and *E. thrax*. But in *E. thrax* a maximum of 22 longitudinal ridges were found in *E. thrax* (Matthew, 2015).

Larval stages: Each larva passed through five distinct instars over a period of 26-33 days. First instar larva nibbled out large oval opening at dorsal part of the egg which first feed on chorion and started feeding from the edge of the leaf parallelly and close with silk through which it started folding the leaf (Fig. 4). First instar larva lasted for 3 - 4 days. Immediately after hatching, larval body was yellow in color later turned to whitish green with dark head. Second and third instars lasted for 2 - 4, 9 -11 days, respectively (Fig. 5). Fourth and fifth

Instars lasted for 5 - 6 and 7 - 8 days, respectively (Fig. 6) (Table 1). The head capsule length of the five instars was 1.29, 1.62, 2.30, 3.16 and 4.62 mm, respectively (Table 2). These findings are in line with Hoffmann (1935) reported on *E. torus*. Fully grown larval body was covered with white waxy matter. The waxy matter may be product from metabolism (Waterhouse *et al.*, 1998). Larva with six ocelli, five ocelli were present nearer to antenna in a semi circular fashion and one ocellus at base of the antenna. The male can be distinguished by the presence pale yellow coloured pair of gonads on dorsal side on sixth abdominal segment (Fig. 7). As the larva grows, it extended the cut and rolled more of leaf into the shelter and larval feaces were found inside the rolled leaf. Older larvae close their rolls or shelters more securely and produce enough waxy powder to be water-repellent. The total larval period of *E. torus* is not much varied from *E thrax* as reported by Mau *et al*. (1980) takes 25 - 30 days, and 20 - 29 days (Khoo *et al*., 1991).

Pupal stage: During the prepupal period of 3 - 4 days, the full-grown larva stopped feeding, turned pale yellow colour and covered with white waxy matter (Fig. 8). The proboscis extended almost up to the cremaster. Pupation took place in rolled leaf itself and packed on both sides. There was not much variation was observed in length of male and female pupa. The female pupal weight ranged 1.71-1.88 g with a mean of 1.80, whereas male pupal weight ranged from 1.41 to 1.74 with a mean of

Table 1. Duration of developmental stages of *Erionota torus* on banana leaves under laboratory condition (mean of 10 observations)

Sl. No.	Life stages		Range (days)	Mean (days)
1.	Incubation period		7 - 9	7.99 ± 0.88
2.	Larval period	I Instar	3 - 4	3.80 ± 0.42
		II Instar	2 - 4	3.20 ± 0.78
		III Instar	9 - 11	9.50 ± 0.70
		IV Instar	5 - 6	5.60 ± 0.51
		V Instar	7 - 8	7.50 ± 0.52
		Total	26 - 33	29.7 ± 0.61
3.	Pre- Pupal period		3 - 4	3.60 ± 0.69
4.	Pupal period		10 - 12	10.9 ± 0.73
5.	Pre oviposivision period		2 - 3	2.40 ± 0.51
6.	Oviposition period		1 - 2	1.40 ± 0.52
7.	Post oviposition period		6 - 7	6.30 ± 0.48
8.	Fecundity/female		18 - 29	27.20 ± 4.70
9.	Male adult longevity		7 - 9	7.90 ± 0.87
10.	Female adult longevity		9 - 12	10.20 ± 1.03
11.	Total life cycle	Male	53 - 67	60.09 ± 3.78
	(egg to adult)	Female	55 - 70	62.39 ± 3.94

Table 2. Length and breadth of adult *Erionota torus* reared on banana leaves under laboratory condition (Mean of five observations)

Details	Length (cm)		Breadth (cm)	
	Range	Mean ± SD	Range	Mean ± SD
Male	6.8 – 7.6	7.27 ± 0.23	2.6 – 3.00	2.76 ± 0.12
Female	6.8 – 7.8	7.35 ± 0.36	2.6 – 3.20	2.86 ± 0.18

Table 3. Measurement of head capsule length and width of different instars of *Erionota torus* (Mean of ten observations)

Stage of insect	Head capsule (mm)			
	Length	Mean ± SD	Width	Mean ± SD
I Instar	1.20 - 1.35	1.29 ± 0.05	1.00 - 1.20	1.10 ± 0.08
II Instar	1.58 - 1.68	1.62 ± 0.04	1.40 - 1.44	1.41 ± 0.02
III Instar	2.14 - 2.48	2.30 ± 0.14	1.84 - 2.40	2.04 ± 0.14
IV Instar	3.10 - 3.20	3.16 ± 0.05	2.25 - 2.82	2.48 ± 0.24
V Instar	4.52 - 4.75	4.62 ± 0.08	3.30 - 3.65	3.45 ± 0.17

1.48 g. The pupal stage lasted for 10-12 days (Table 1). The earlier workers reported the pupal period of *E. thrax* is about 10 days (Mau *et al*., 1980; Waterhouse and Norris, 1989) and 8 - 12 days (Khoo *et al*., 1991). The pupal period was in conformity with the findings of Soumya *et al*., (2013). The pupa was highly sensitive to slight touch (Corbert and Pendlebury, 1978). When it was about to emerge eyes turned complete red colour. Pupal sexing can be done by looking at the genital opening. In female, the genital pore or opening was found ventrally on 8th abdominal segment (Fig. 9). The opening starts with 8th abdominal segment and bisects its caudal margin and the opening extends posteriorly into the anteriar region of the 9th segment. In case of male, shorter genital opening with two distantly elevated tubercles were found ventrally on 9th abdominal segment (Fig. 10). In both the sexes, anal openings were found on 10th abdominal segment.

Adult: Freshly emerged adults were brownish with three yellowish spots on the forewing and hind wings which are of brownish in colour. Based on the abdominal tip males and females were identified (Figs. 11 and 12). There were three yellowish orange spots in the centre of the dorsal side of the forewing of which two or more or less equal in size which other is relatively small. More than 95 per cent of the adults emerged during afternoon hours (n = 50). In banana plantation, the adult butterflies were found actively flying during morning and evening hours and attracted to light and fly rapidly and erratically in evening and morning hours. Adults were also found to feed on nector from banana inflorescence (Fig. 13). Pre-oviposition, ovipositioion and post oviposition period ranged from 2 - 3, 1 - 2 and 6-7 days, respectively. In captivity, each female laid 18 to 29 eggs with an average of 27.20. The total life cycle of male and female ranged from 53 - 67 and 55 - 70 days, respectively (Table 1). Okolle *et al*., (2010) reported that *E. thrax* can lay eggs up to 60 and even more depending on the quality of the food. This variation in fecundity is due to species difference.

The female skipper survived for 10.20 days with a range of 9 - 12 days compared to male (7.9 days)

with a range of 7 - 9 days (Table 1). The average wingspan of female was 7.35 cm with a range of 6.8 to 7.8 cm and 2.86 cm breadth with a range of 2.60 to 3.20 cm. While in male, it was 7.27 cm with a range of 6.80 to 7.60 cm and 2.76 cm breadth with a range of 2.60 to 3.00 cm (Table 3). These results are in line with the findings of Waterhouse and Norris (1989).

Food consumption, growth and utilization: The data for the weight of food consumed and weight gained by the larvae are given in Table 4.The same data could not be collected for instar I due to its small size with consequent difficult in handling. The amount of food consumed increased from instar to instar, the proportion of total food consumed in instars from II to V being 10.28, 23.13, 25.01 and 41.56 %. Thus, there was greatest consumption in instar V. The weight gain corresponded to the food consumption trend of the respective instars. The weight gain in instar III was 33.51% of total larval weight. The values of growth rate (GR) decreased from instar II to to instar V, the values varied between 0.03 and 0.16 g/day/g. Consumption index (CI) values ranged between 0.64 and 2.15 g/day/g. The indices of food utilization efficiencies AD, ECI, and ECD. The range of AD values was 80.89 to 97.86%, that of ECI. 6.86 to 13.00 % and ECD. 7.90 to 15.90 % (Table 4). Adult feeding on the banana inflorescence may helps them to obtain proteins and carbon sources with such nutrient uptake helps in egg productivity. The larval food also appears to be highly nutritional as indicated by the observed values of assimilation efficiency (AD), the efficiency of conversion of ingested food (ECI), and the efficiency of conversion of digested food (ECD) into the body substance.

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Table 4. Mean Food consumption, growth and food utilization efficiencies of *Erionota torus* larva fed with banana leaves (N=10)

Instar	Wt. of food ingested (g)	Wt. of faeces (g)	Wt. gained by larva (g)	Mean wt of the larva during feeding	Number of feeding days	CI (g/day/g)	GR (g/day/g)	AD (%)	ECD (%)	ECI (%)
I*	-	-	-		-	-	-	-	-	-
II	4.22 ± 0.12	0.09 ± 0.01	0.33 ± 0.14	0.49	4.00	2.15	0.16	97.86	7.90	7.81
III	9.49 ± 0.55	1.71 ± 0.06	1.24 ± 0.43	1.21	11.00	0.71	0.09	81.98	15.90	13.00
IV	10.26 ± 0.26	1.96 ± 0.08	0.96 ± 0.41	1.63	6.00	1.04	0.09	80.89	11.50	9.35
V	17.05 ± 2.10	2.72 ± 0.45	1.17 ± 0.43	3.28	8.00	0.64	0.03	84.04	8.10	6.86

* : Indicates no data due to very small size of first instar.
CI = Consumption index: GR = Relative growth rate; AD = Approximate digestibility
ECD = Efficiency of conversion of digested food into body matter
ECI = Efficiency of conversion of ingested food into body matter

REFERENCES

Bascombe M. J., Johnston G. and Bascombe F. S. (1999) The Butterflies of Hong Kong. Academic Press, London. xiii + 422 pp, 222 plates.

Corbet A. S. and Pendlebury H. M. (1978) The Butterflies of the Malay Peninsula, 3rd edn, revised by Eliot JN. Art Printing Works SDN, BHD, Lumpur K, Malaysia.

Ghorpade K. and Kunte K. (2010) Butterflies of the Palani Hills, Southern Western Ghats in Peninsular India. Colemania, 23: 1-19.

Gunawardana B. R. Wijewardana G. V. I. H., Herath H. M. B. E. and Priyadarshana T. M. T. S. (2015) *Erionota torus* Evans, 1941. A new record for Srilanka with notes on its biology (lepidoptera: hesperiidae). Wildlanka, 3: 178 - 183.

Hoffmann W. E. (1935) Observations on a hesperid leaf-roller and a lace-bug, two pests of banana in Kwangtung. Lingnan Science Journal, 14: 634-49.

Inoue S. and Kawazoe A. (1970) Hesperiid butterflies from South Vietnam. Trans. Lep. Soc. Jap., 21: 1-14.

Igarashi S. and Fukuda H. (1997) The Life Histories of Asian butterflies. Tokai University Press.Tokyo, Japan 1: 547.

Kamala J. P. D., Rami R. P.V., Vivek K. and Shashank P. R. (2015) Outbreak of banana skipper, *Erionota torus* Evans (Lepidoptera: Hesperiidae) in southern India. Evidence of expanded geographic range, Pest Management in Horticultural Ecosystems, 21: 95-97.

Matthew J. W. C. (2015) A critical review of the literature on the pest *Erionota* spp. (Lepidoptera, Hesperiidae): taxonomy, distribution, food plants, early stages, natural enemies and biological control. CAB Reviews, 10: 1-30.

Okolle J. N., Mashor M. and Ahmad A. H. (2006) Spatial distribution of banana skipper (*Erionota thrax* L.) (Lepidoptera: Hesperiidae) and its parasitoids in a Cavendish banana plantation, Penang, Malaysia. Insect Science, 13: 381-389.

Okolle J. N., Abu H. A. and Mashhor M. (2009) Infestation and parasitism of banana skipper (*Erionota thrax)* (Lepidoptera: Hesperiidae) in relation to banana leaf age, and surface and distance from field edge. Asian and Australian Journal of Plant Science and Biotechnology, 3: 61-65.

Okolle J. N., Abu H. A. and Mashhor M. (2010) Bioecology and Management of the Banana Skipper (*Erionota thrax*).Tree and Forestry Science and Biotechnology, 4: 22-31.

Padmanabhan B. (2014) Occurrence of Banana Skipper *Erionata thrax* (L.), a defoliator of banana in certain parts of India. In: Global conference on technological challenges and human resources for climate smart horticulture. NAU, Navsari, Gujarat.

Prasad B. and Singh O. L. (1987) Insect pests of banana and their incidence in Manipur. Indian Journal of Hill Farming, 1: 71-73.

Raju D., Kunte K., Kalesh S., Manoj P. H. and Ogale R. S. (2015) *Erionota torus* Evans, 1941 – Rounded Palm-redeye. Kunte K, Roy P, Kalesh, Kodandaramaiah U. Butterflies of India. Indian Foundation for Butterflies, 2: 29.

Singh M. P. (1997) *Erionata thrax* Linn., a serious pest of banana in Manipur and its potential biocontrol agent, *Brachymeria euploeae* (West). Insect Environment, 3: 51-52.

Sivakumar T. T., Jiji N. and Anitha (2014) Field observations on banana skipper *Erionota thrax* L. (Hesperiidae: Lepidoptera) and its avian predators from southern peninsular India. Current Biotica, 8: 220-227.

Soumya K. C., Sajeev T. V., Maneetha T. K., Keerthy V. and George M. (2013) Incidence of *Erionota thrax* (Hübner) (Lepidoptera: Hesperiidae) as a pest of banana in Kerala. Entomon, 38: 53-58.

Tipple A. D. and Ghorpade K. (2012) Butterflies of A-A-Biosphere in Chattisgarh and M.P. Colemania, 26: 1-38.

Veenakumari K. and Mohanraj P. (1991) *Erionota thrax* L. (Lepidoptera: Hesperiidae), a new record to Andaman Islands. Journal of the Andaman Science Association, **7**: 91-92.

Waldbauer G. P. (1968) The consumption and utilization of food by insects. In: Beament, Trehern, Wigglesworth. Advances in insect physiology. Academic Press, London and New York, 229-288.

Waterhouse D. F. and Norris K. R. (1989) Biological Control. Pacific Prospects Supplement 1, ACIAR Monograph No.12, pp 89–99.

WynterBlyth (1957) Butterflies of the Indian Region. Bombay Natural History Society, 523 p.

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